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(71) Applicant: **AUTOSTRADE CONCESSIONI E COSTRUZIONI AUTOSTRADE S.P.A.**
Via A. Bergamini 50
I-00159 Roma(IT)

(72) Inventor: **Ceseri, Pierluigi**
Via Francesco da Barberino, 23
I-50100 Firenze(IT)

(74) Representative: **Modiano, Guido et al**
MODIANO, JOSIF, PISANTY & STAUB
Modiano & Associati Via Meravigli, 16
I-20123 Milano(IT)

(54) Automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks.

(57) An automatic toll exaction system which comprises an onboard apparatus (5-9) which can be mounted onboard a motor vehicle (1) for the reception and transmission of messages, the handling and storage of the transactions and for interaction with the user, a personal card suitable (1) for activating the onboard apparatus, identifying the user and storing the payment transactions, and a ground-based apparatus (3,4) for ensuring the linkup with the onboard apparatus (5-9) for the exchange of data and messages, for sensing physical parameters suitable for classifying the vehicle and for performing the processing of the data and parameters supplied by the onboard apparatus (5-9) and sensed by the ground-based apparatus (3,4) itself.

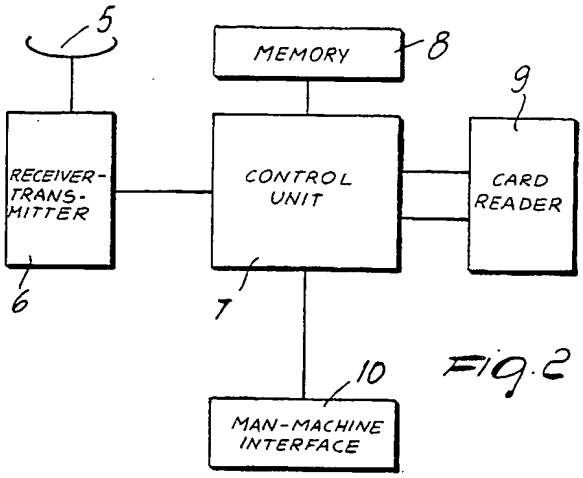

Fig. 2

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AUTOMATIC TOLL EXACTION SYSTEM FOR URBAN AND EXTRAURBAN HIGHWAYS, FOR BRIDGE AND TUNNEL CROSSINGS AND FOR ACCESSES TO URBAN AREAS AND CAR PARKS

The present invention relates to an automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks.

As is known, through the years, in view of the fact that the highway system has a strategic role of development and integration of the territory, an extensive integrated network capable of providing the necessary assurances of ease of transit as well as new services related to stops and to increasingly complete tourist-cultural information and information on road conditions has been developed. In particular, in order to increase fluidity, safety and comfort on the highway network, and in order to reduce the congestion of traffic near stations, which is endured by highway users with rising intolerance, there has been a constant commitment aimed at the adaptation of the structures and to the development of automation. A further fluidizing factor is constituted by the possibility of paying the toll by means of electronic money in the two forms with a "prepaid charge-deduction" card or with charging either directly or by means of contracted organizations or finally with charging to a bank account (VIACARD system).

However, the need for further improvement in transportation and fluidity on the main multimodal lanes and for adaptation of accesses to metropolitan areas is felt.

Consequently, the aim of the present invention is to provide an automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks which can satisfy these requirements of improvement in transportation by means of the dynamic exaction of the toll.

Within the scope of this aim, a particular object of the present invention is to provide an automatic toll exaction system which can:

- simultaneously provide the diffusion of precise and timely information on road conditions and on the services offered;
- ensure greater fluidity, safety, reduction of pollution near stations and energy saving, since the vehicle no longer needs to stop in the lane but can pass at the speed enforced by safety regulations;
- have great reliability and modularity to ensure the progressive introduction of the various provided services and the easy implementation of the new ones;
- be easily integrated in the existing structures, as regards both the vehicles and the road, and in particular the configuration of the stations.

The system according to the invention must furthermore be compatible and interactive with currently installed exaction systems, allow to maintain the currently existing monetics circuits and allow opening to integration with information processing systems.

This aim, the objects mentioned and others which will become apparent hereinafter are achieved by a toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks, as defined in the accompanying claims.

The characteristics and advantages of the invention will become apparent from the description of a preferred embodiment, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a schematic view of the three essential components of the system according to the invention;

figure 2 is a block diagram of the onboard apparatus;

figure 3 is a schematic view of the configuration of a station executed according to the invention, illustrating the division of the areas affected by the system;

figure 4 is a block diagram of the ground-based apparatus; and

figures 5-8 are block diagrams of the steps for automatic toll exaction according to the invention.

With reference to figure 1, the system according to the invention is substantially composed of three parts, and precisely an onboard apparatus (composed of the units shown in figure 2) mounted inside a motor vehicle 1 in a position which can be accessed by the driver, a personal card 2, which must be inserted in the onboard apparatus in order to use the toll exaction system according to the invention, and a ground-based apparatus (represented in figure 1 by a buoy 3 on which an antenna 4 is mounted and schematically indicated in figure 4) which ensures linkup with the onboard apparatus and the processing of the data for toll exaction. This ground-based apparatus also allows connection to the existing information-processing and automation units.

The onboard apparatus has the function of ensuring the reception and transmission of the messages, the handling and storage of the transactions and the interaction with the user (generally the driver). In detail, said apparatus (see figure 2) comprises a ground-to-vehicle radio-link section (composed of an antenna 5 and of a reception and transmission device 6 of a known type), an in-

formation processing section (composed of a control unit 7 with a memory 8 of its own), a section for reading and encoding the card (card reader 9) and a man-machine interface 10 which is typically constituted by a display unit, which includes a red LED and a green LED for displaying messages sent by the ground-based apparatus or generated by the control unit 7, and by a two-tone acoustic alarm system for attracting the user's attention and repeating the visual indication provided by the LEDs. A third yellow LED can furthermore be provided; when lit, said LED indicates that the card can no longer be removed from the reader. Finally, means suitable for allowing the user to receive further information concerning road conditions and traffic may be provided. Said means may be constituted for example by displays and/or loudspeakers or other solutions suitable for the purpose, as well as by elements for connection to the devices which are already available on board (radio, etc.).

The personal card, which for example can be executed as an extension of the VIACARD (Trade Mark) cards, has the function of activating the onboard apparatus, of identifying the user and of storing the operative data (such as the operativity or locking of the card as well as the transactions for the payment of the toll or of other goods or services). Conveniently, in order to ensure that the dialogue is confidential, to protect access to the system and store the operative data, said card is executed according to the technology of microprocessor-equipped cards which also contain electrically rewritable memories. The card furthermore conveniently has, on the same support, magnetic tracks recorded according to the currently applicable codings to allow the use of the same card (which is removable from the onboard apparatus) even with conventional station apparatuses for automatic toll exaction and with those being installed for the payment of fuels and refreshments.

As will be explained in greater detail hereinafter, once the card is inserted in the onboard apparatus, it is checked upon entering the highway and stores the characteristic data in replacement of the ticket for the completion of the exit transaction. It furthermore stores each individual transaction supporting each charge, thus constituting a memorandum of the trips made for the user, contains the restrictions of use (limit differentiated by service and in time) and also verifies and stores the occurrence of the enabling on the part of the system to the fruition of the service by means of checks on a blacklist or "white list", according to the preset procedures.

The ground-based apparatus, as already mentioned, has the function of communicating with the onboard one for the exchange of the data and messages required to ensure the dynamic exaction of the toll and the transmission of general information on road conditions and traffic, as well as of performing the necessary processing of the data. In particular, two different transmission modes, which are simultaneously present with automatic passage from one to the other, are provided according to the content of the messages. The first mode is aimed at a single user for the dynamic exaction of the toll by means of a selective linkup (in particular with the identification and classification of the vehicle and with the association thereof with the card inserted in the onboard apparatus). This entails the need to locate the vehicle and to maintain a one-to-one correspondence between the physical parameters detected by means of the ground-based instruments and the user identification data gathered by radio. The second transmission mode is aimed at many users (circular transmission) for the broadcasting of news of general interest, such as the state of the roads or the availability of services. In particular, in this case, the ground-based apparatus allows to send information on road conditions, on the presence of road yards, traffic blocks and detours, on travel times, recommended alternate paths, availability of services and weather conditions, and on the presence of personal messages at the nearest service station. This system, in a simpler configuration, allows to carry this information along the highway and possibly, by means of appropriate installations, even along the ordinary road system.

Consequently, each individual station executed according to the present automatic exaction system has the structure shown in figure 3. In said figure, the reference numerals 16 indicate two portions of highway which can be followed in the outgoing direction (typically they represent the two junction roads with the carriageways or lanes of the highway), 17 indicates the portion after the toll station which can be followed in the ingoing direction toward the actual highway, 18 represents a road (e.g. a provincial road) which is linked to the highway by means of the portions 16 and 17, and 19 indicates the station. The station, according to the invention, comprises a plurality of areas in which the messages necessary for automatic exaction are exchanged. In detail, three areas are provided and correspond to three logic steps which are repeated both in entry and in exit in case of a closed highway system:

a) a first approach step, during which the ground-based system broadcasts circular signals to communicate the availability of the service and activate the onboard apparatus which, passing from a listening state to an active one, performs all the auto-diagnostics checks and the card functionality checks. The positive outcome

of these checks, which is notified to the user, authorizes said user to continue toward the gate enabled for the tele-toll service; otherwise an alarm indication requests him to move toward another gate with manual or automatic exaction. This step is performed in the areas indicated by AREA 1E (for entering the highway) and AREA 1U (for leaving said highway). The areas 1E and 1U are chosen so that in this step the vehicle is normally not routed, and the radioelectric coverage is extended enough to ensure linkup with all the passing vehicles which are potentially interested in the message. In this region, transmission is of the one-way type, from the ground to the vehicle.

b) a second presentation step, during which the onboard apparatus communicates the user's identification data while the ground-based apparatuses determine the class of the vehicle for the application of the toll fare. In this step, which is performed in the regions indicated by AREA 2E (for entry) and AREA 2U (for exit), the correspondence between the data acquired by radio and those measured on the ground must be ensured: the link is of the two-way type and the traffic is already routed.

c) a third validation step, during which the ground-based system authorizes transit, on the basis of the checks performed on the data acquired in the preceding step, and transfers the related identification data to the vehicle. In case of failed authorization, the ground-based apparatus enables the acquisition and storage of the frame which contains the registration plate of the vehicle involved. This step is performed in the regions indicated by AREA 3E (for entry) and AREA 3U (for exit).

The station illustrated in figure 3 is part of a closed system (i.e. in which toll exaction is performed by calculating the distance covered and the tariff class and each area is repeated in entry and in exit); however, the same scheme is used for open systems (i.e. systems in which there are one or more stations in which the payment of the toll related to a certain highway segment is performed as a function of the segment itself and of the class of the vehicle). In particular, the same three steps described above, which correspond to the three areas of approach, presentation and validation, are identified in this case as well, but the entire transaction is performed in a single station, as will be explained in greater detail hereinafter.

Figure 4 schematically illustrates the units which compose the ground-based apparatus. In particular, the entry buoy 1 (BOA 1E) arranged at the AREA 1E and the exit buoy 1 (BOA 1U) located at the AREA 1U are represented. Said buoys are arranged physically remote from the related station, so that an RS422 line is provided for exchanging data with the station computer. One or two additional buoys (BOA 1S) which replicate the entry and/or exit buoy 1 proximate to the station are possibly provided. A monitor is furthermore connected to the computer for control on the part of an operator. The ground-based apparatus furthermore comprises a lane processing unit, indicated by 20, which is arranged at each lane and is therefore provided at least twice, for the entry lane and the exit lane. Said unit 20 comprises a lane computer, a CTV unit which constitutes a classification and unlocking system, a logical unit for the control of the buoys (BUOY LOGIC + CONTROLLERS) and a unit for communication between the lane computer and the station computer. The entry or exit presentation and validation buoys (BOA 2, BOA 3), according to the type of lane, lane sensors which are arranged proximate to the entry and exit buoys 2 and 3 and are typically constituted by a pair of contiguous optical barriers and by a presence sensing coil, and a TV camera with the respective SART computer for detecting the registration plates are connected to the processing unit 20 as will be explained hereinafter.

All the buoys have highly directive and very small antennas which operate typically between 5 and 11 GHz.

The automatic toll exaction system according to the invention operates as described hereafter with reference to the block diagrams of figures 5-9.

In particular, figure 5 illustrates the block diagram related to the operations performed by the onboard apparatus during the approach step both for the closed system (and related to both entry and exit) and for the open system. In detail, the buoy BOA 1 broadcasts its own activity signal in a continuous cycle; said signal contains a variable text to be recorded on the onboard apparatus. The onboard apparatus, which was previously in the listening state, is activated when the vehicle enters the AREA 1E or 1U and receives the buoy activity signal. Lack of reception does not enable for transit on the dedicated lanes. Reception of the activity signal instead causes the beginning of the self-test sequence of the assembly constituted by the onboard apparatus and by the inserted card. The correct insertion of the card in the reader is initially checked, with a possible indication in case of negative outcome, then the self-test sequence continues in order to check the read/write capability, possible hindrances to the use of the card and the non-corruption of the recorded data. Then the outcome of the test is indicated by means of the display and/or of an acoustic signal and possibly, in case of positive outcome, the message of the buoy is examined and indicated to the user.

Figure 6 illustrates the block diagram related to

the operations performed by the ground-based apparatus during the entry presentation step. At the beginning of this step, the ground-based apparatus is waiting for the sensing of the passage of a vehicle on the part of the sensors arranged in AREA 2. As soon as a vehicle is sensed, the buoy broadcasts a cyclic code which has the function of a query for the vehicle. The onboard apparatus replies by providing its own card code plus the cyclic code assigned thereto and furthermore stores on the card said cyclic code and a marker to indicate the locked condition. This means that the card cannot be removed until the end of the writing of said card during the validation step. The onboard apparatus furthermore stores the code of the card in its non-volatile memory (memory 8 of figure 2) to avoid exchanges of the card itself between the entry station and the exit station, as will be explained hereinafter. The units which control the buoy, which after the broadcasting of the cyclic code has set itself to standby for the data supplied from the vehicle, upon the reception of said data perform the matching between the cyclic code and the card code and the transfer of these data to the lane computer SCP. If the data are not received, this fact is indicated to the SCP and the dialogue is terminated. Then the buoy continues with the querying of the following user by means of the following number of the cyclic code. The SCP, after the reception of the data from the buoy, performs the formal checks on the card, checks the inclusion of the received code in blacklists and in allowance ranges and furthermore classifies the vehicle.

Figure 7 illustrates the block diagram of the entry validation step (and of the exit validation step, as will become apparent hereinafter). At the beginning of this step, the ground-based apparatus is standing by for the sensing of the passage of a vehicle on the part of the sensors arranged in AREA 3. As soon as a vehicle is sensed, if the transit is not a violation (for example due to the absence of the onboard apparatus or of the card, or to the lack of enabling of the latter or other transit anomalies) and if the card code is acceptable, the buoy sends the message for the awaited vehicle; in this case said message contains the data related to the highway entry, such as the station code, the date and time, the detected class, the inclusion in the blacklist and the inclusion in the allowance ranges as well as the cyclic code to which the data refer. These data can thus be stored on the card. Then the buoy sets itself to a state of standby for the reception of a return confirmation on the part of the vehicle. The confirmation of the correct reception and correspondence of the data (cyclic code equal to the one received during the presentation step) returning from the onboard apparatus must be received by the lane system before the vehicle leaves the lane control sensors. Otherwise, the lane computer activates the registration plate identification and at the same time transfers the value of a counter, which is provided in BOA 3E and stores the progressive number of transits, to the computer which is responsible for the acquisition of the photographs. Registration plate detection is also activated when an illegal transit is sensed, the card has an unacceptable code or there is an unrecoverable error in ground-vehicle data exchange. The reception of confirmation or the acquisition of the registration plate in case of illegal transit or in case of failed confirmation cause the shutdown of the operations related to the transit.

At the end of the writing of the data on the card, the onboard apparatus finally erases the marker on the card, which can therefore be removed from the reader if required.

As regards the exit steps of a closed highway system, these steps are again divided into an approach step, which is equal to the one already described with reference to figure 5, a presentation step, which is now described with reference to figure 8, and a validation step which is similar to the one described with reference to figure 7.

The exit presentation step is very similar to the entry one. Consequently, at the beginning of this step the ground-based apparatus is standing by for the sensing of the passage of a vehicle on the part of the sensors arranged in AREA 2U. As soon as a vehicle is sensed, the buoy broadcasts the cyclic code. The onboard apparatus replies by providing its own card code plus the cyclic code assigned thereto as well as the other data stored at highway entry and furthermore stores on the card said cyclic code and a marker to indicate the locked condition. The units which control the buoy, which after the broadcasting of the cyclic code has set itself to standby for the data supplied from the vehicle, when said data are received, sends them to the lane computer SCP. In the absence of data reception, this fact is indicated to the SCP and the dialogue is terminated. Then the buoy continues with the querying of the following user by means of the following number of the cyclic code. The SCP performs the formal checks on the card, checks the inclusion of the received code in blacklists and in allowance ranges as well as the correspondence of the data with the entry data (in particular as regards the times, the entry and exit stations and the class of the vehicle) and furthermore calculates the toll as a function of the class and distance covered.

At the beginning of the validation step (see again figure 7), the ground-based apparatus is in stand by for the sensing of the passage of a vehicle at the sensors arranged in AREA 3. As

soon as a vehicle is sensed, the buoy sends the querying message for the awaited vehicle; said message contains the exit data related to the payment of the toll, such as the amount of the toll, the exit station code, the exit lane code, the exit date and time, the class detected in exit, inclusion in the blacklist and inclusion in the allowance ranges. These data are sent to the onboard apparatus, which stores them, possibly deducting the amount of the toll from the existing limit, and then sends a confirmation toward the buoy. The reception of this confirmation on the part of the ground-based apparatus terminates the transaction. Anomalies in communications cause the activation of the registration plate detection in exit as well.

Finally, at the end of the writing of the data on the card, the onboard apparatus erases the marker on the card, which can thus be removed from the reader, and erases the card number stored in the memory of the onboard apparatus, which can therefore perform the subsequent transactions even with different cards.

In the case of open systems, the structure of the toll station is similar to the one shown in figure 3, with the difference that the stations do not have entry and exit areas but only exit areas 1, 2, 3 for the vehicles traveling in both directions, and the logic steps of each transaction substantially correspond to those described for closed systems and are constituted by an approach step, similar to the one described with reference to figure 5, by a presentation step, identical to the one described with reference to figure 6, and by a validation step which is identical to the one for exit in closed systems described with reference to figure 7. The main differences are: the vehicle encounters the exit system directly; during the presentation step, the entry data are not sent from the vehicle to the ground; the toll is determined only on the basis of the class of the vehicle.

Conveniently, according to the invention, all the dialogues between the onboard apparatus and the ground-based apparatus provide the possibility of repeating the messages at least one second time in case of error.

As can be seen from the preceding description, the invention fully achieves the proposed aim and objects. A system has in fact been provided which can perform the dynamic exaction of the toll and in particular is capable of automatically acquiring the data related to entry and exit for the definition of the distance covered, of identifying the physical characteristics of the vehicle and the assignment of the tariff class, of recognizing the user, checking the user's inclusion in allowance lists and recording the transaction, deducting the related amount from the card or performing the charging, directly or by means of contracted organizations or on banking circuits, in a known manner.

The system is compatible with both manual and automatic currently installed exaction systems, operates with both open and closed highways and is capable of providing a complete service by virtue of the possibility of informing the user of the presence of enabled gates and of authorizing him to transit.

The system according to the invention is furthermore extremely reliable by virtue of the detection of the class both in exit and in entry, of the automatic comparison in exit and of the automatic recording of the registration plate for every operation which is found negative by the set of correspondence checks performed, as well as of the validity check of the cards both in entry and in exit.

The invention thus conceived is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept.

All the details may furthermore be replaced with other technically equivalent ones.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks, characterized in that it comprises an onboard apparatus (5-9) which can be mounted onboard a motor vehicle (1) for the reception and transmission of messages, the handling and storage of the transactions, the interaction with the user and the sending of messages to said user, a personal removable card (2) suitable for activating the onboard apparatus (5-9), identifying the user and storing the payment transactions, and a ground-based apparatus (3,4) suitable for ensuring the linkup with the onboard apparatus (5-9) for the exchange of data and messages, for sensing physical parameters related to the vehicle, for performing the processing of the data and parameters supplied by said onboard apparatus (5-9) and sensed by said ground-based apparatus (3,4) as well as for transmitting and receiving messages in connection with central data processing systems.

2. System according to claim 1, characterized in that said onboard apparatus (5-9) comprises a reception and transmission unit (6) connected to an antenna (5), a control unit (7) provided with a

memory (8) of its own, a reader (9) for the card, a display (10) for the messages which are generated by said control unit (7) and/or sent by said ground-based apparatus (3,4), and acoustic alarm means (10).

3. System according to claim 1, characterized in that said card (2) has a microprocessor of its own and an electrically rewritable memory.

4. System according to one or more of the preceding claims, characterized in that said card (2) has magnetic tracks for reading by means of said onboard apparatus and for reading by means of conventional station devices.

5. System according to one or more of the preceding claims, with a plurality of exaction stations (19) , characterized in that each exaction station (19) comprises at least one first approach area (1E,1U), a second presentation area (2E,2U) and a third validation area (3E,3U).

6. System according to one or more of the preceding claims, characterized in that said at least one approach area (1E,1U) comprises a radioelectric buoy (BOA 1E, BOA 1U) which has its own antenna for broadcasting circular messages.

7. System according to one or more of the preceding claims, characterized in that each of said presentation (2E,2U) and validation areas (3U,3E) comprises its own radioelectric buoy (BOA 2, BOA 3) provided with an antenna for the exchange of data and messages with the onboard apparatus as well as sensors for sensing the presence and the movements of a vehicle and for its classification.

8. System according to one or more of the preceding claims, characterized in that said sensors comprise a pair of contiguous optical barriers and a presence-sensing coil.

9. System according to one or more of the preceding claims, characterized in that said validation area comprises a TV camera for the acquisition of the registration plate of the vehicle.

10. System according to one or more of the preceding claims, characterized in that said ground-based apparatus (3,4) comprises a lane computer (20) which is associated with said presentation and validation areas (2U,2E,3U,3E) and is connected to said radioelectric buoys (BOA 2, BOA 3) of the presentation and validation areas (2U,2E,3U,3E), to said sensors and to said TV camera, said lane computer (20) being connected by means of a local network to a central station computer connected to said radioelectric buoy (BOA E, BOA U) of the approach area.

11. System according to one or more of the preceding claims, characterized in that said radioelectric buoy (BOA 2) of the presentation area (2E,2U) comprises a counter for generating cyclic codes which are sent by means of said antenna to said onboard apparatus, and in that said radioelectric buoy (BOA 3) of the validation area (3E,3U) comprises a counter for generating a progressive transit number.

12. Process for the automatic exaction of toll for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks, in a system according to one or more of the preceding claims, characterized in that it comprises a step of approach for the communication of the availability of the service and the activation of the onboard apparatus, a step of presentation for the acquisition of the user's identification data and for the determination of the class of the vehicle, and a step of validation for authorization to transit and the possible acquisition of the registration plate.

13. Process according to the preceding claim, characterized in that said approach step comprises the transmission of an activity signal on the part of a radioelectric buoy, the activation of the onboard apparatus upon the reception of said activity signal, the execution of auto-diagnostics checks and of card functionality checks on the part of said onboard apparatus and the indication, on said onboard apparatus, of messages which are related to the result of said checks and/or are sent by the ground-based apparatus.

14. Process according to one or more of the preceding claims, characterized in that said step of presentation in entry in closed systems and for open systems comprises the sensing of a motor vehicle on the part of sensors, the broadcasting of a cyclic code on the part of a radioelectric buoy, the storage of a locking marker on the card, the storage of the card code and of the cyclic code in a memory of the onboard apparatus, the transmission of the data of the card and of the cyclic code to the radioelectric buoy and to a lane computer, the execution of formal checks on the card and the classification of the vehicle.

15. Process according to one or more of the preceding claims, characterized in that said validation step in entry to highway systems of the closed type comprises the sensing of the vehicle on the part of sensors, the request of the cyclic code stored by the onboard apparatus during the entry presentation step and of the card code, the execution of formal checks on these data, the transmission of the data related to the highway entry toward the onboard apparatus, the transmission of the confirmation of reception on the part of the onboard apparatus and possibly the detection of the registration plate in case of detection of anomalies in the transit and in the ground-to-vehicle transmissions.

16. Process according to one or more of the preceding claims, characterized in that said exit presentation step of closed highway systems com-

prises the sensing of a motor vehicle on the part of sensors, the broadcasting of a cyclic code on the part of a radioelectric buoy, the storage of a locking marker on the card, the transmission of the data of the card, of the cyclic code and of the previously stored entry data to the radioelectric buoy and to a lane computer, the execution of formal checks on the card and on the received data and the calculation of the toll.

17. Process according to one or more of the preceding claims, characterized in that said exit validation step of highway systems of the closed type and in highway systems of the open type comprises the sensing of the vehicle on the part of sensors, the request of the cyclic code stored by the onboard apparatus during the exit presentation step and of the card code, the execution of formal checks on these data, the transmission of the data related to the exit from the highway and to the payment of the toll to the onboard apparatus, the transmission of confirmation of reception on the part of the onboard apparatus and possibly the detection of the registration plate in case of the detection of anomalies in the transit and/or in ground-to-vehicle transmissions.

18. Process according to one or more of the preceding claims, characterized in that said ground-to-vehicle data exchange step also comprises the sending of messages concerning traffic and road conditions from the ground to the vehicle.

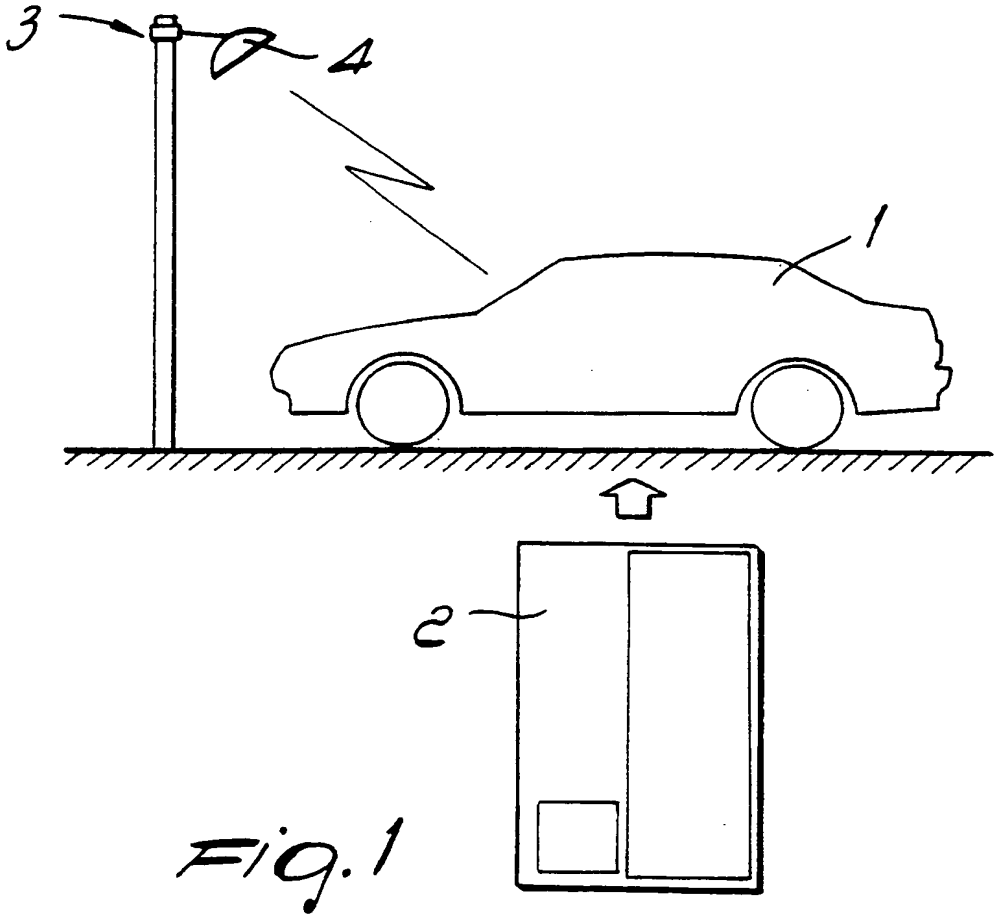
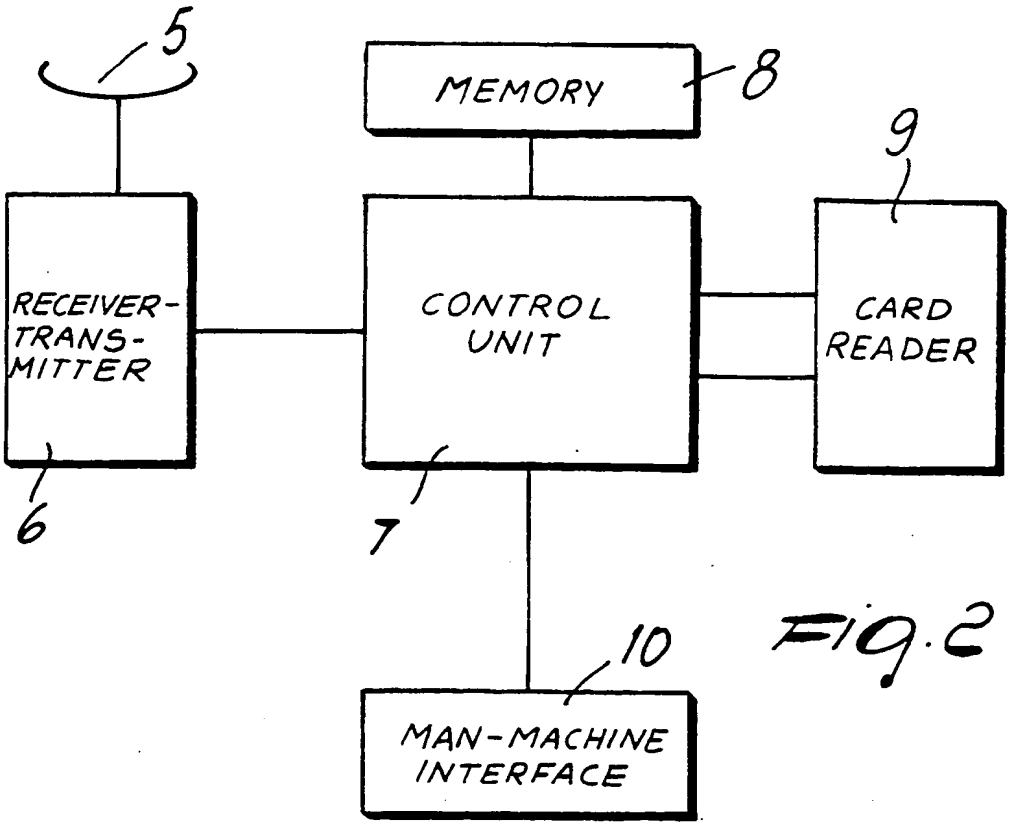

3
4
1
2

Fig.1


5
MEMORY
8
9
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TRANS-
MITTER
CONTROL
UNIT
CARD
READER
6
7
10
MAN-MACHINE
INTERFACE

Fig.2

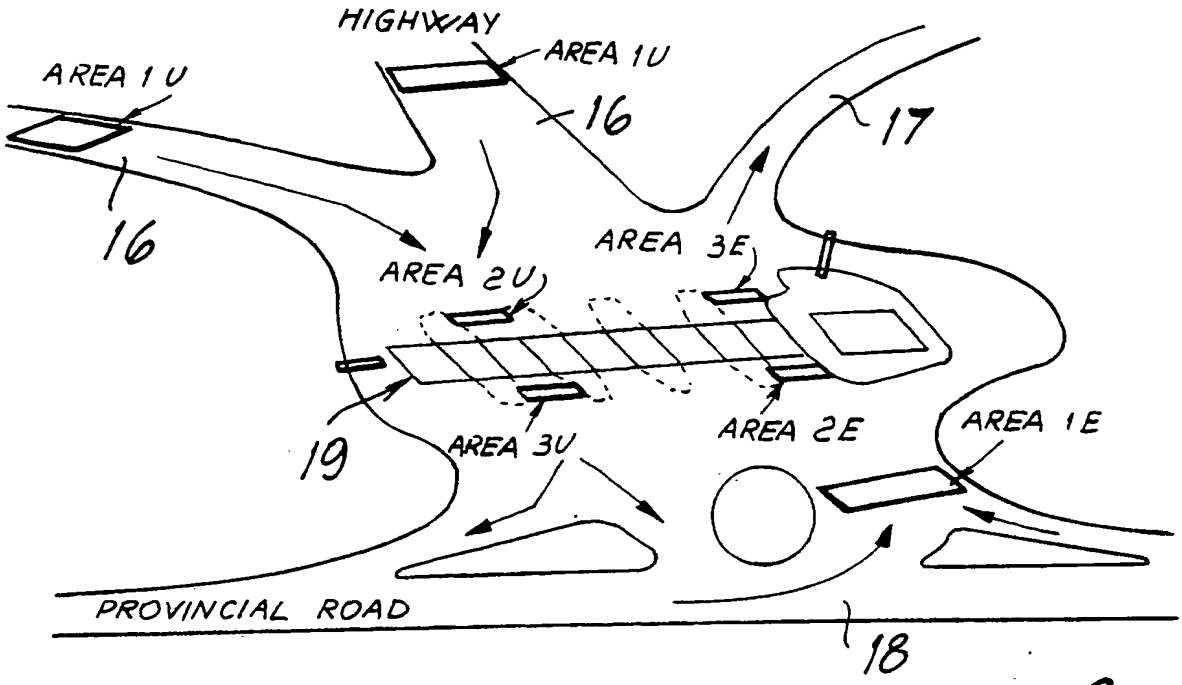
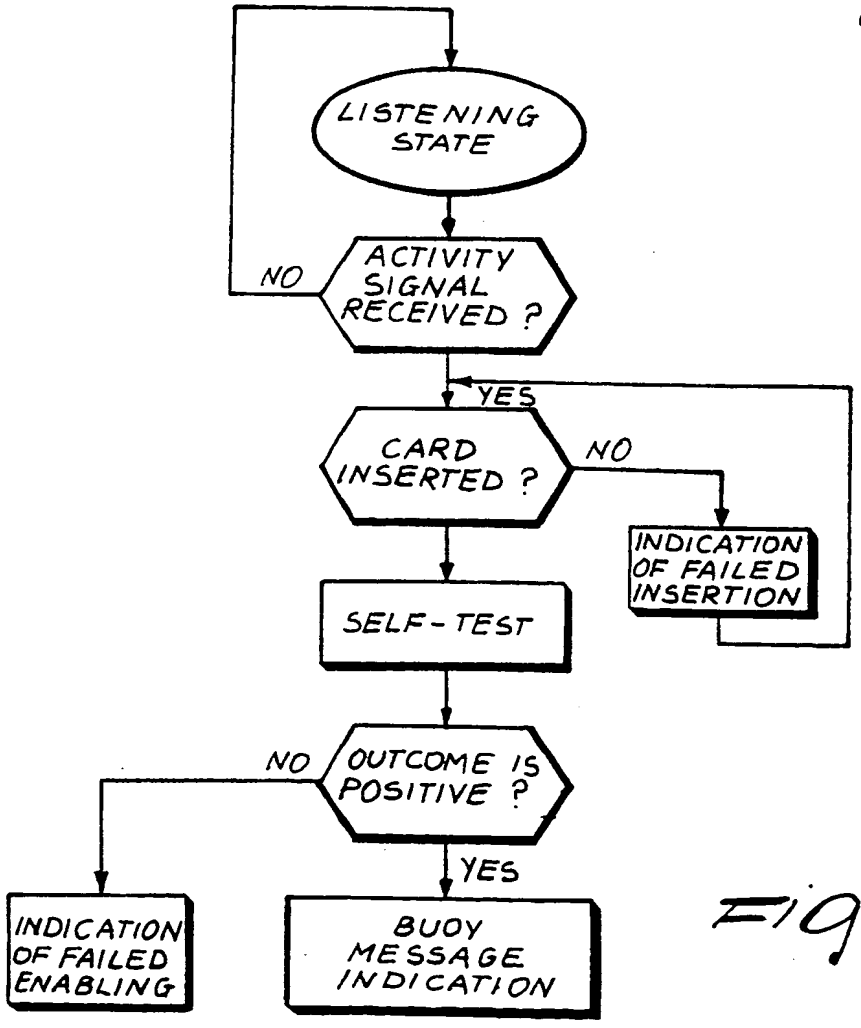

HIGHWAY
AREA 1U
AREA 1U
16
17
16
AREA 2U
AREA 3E
19
AREA 3U
AREA 2E
AREA 1E
PROVINCIAL ROAD
18

Fig.3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ACTIVITY SIGNAL RECEIVED ?
YES
CARD INSERTED ?
NO
INDICATION OF FAILED INSERTION
SELF-TEST
NO
OUTCOME IS POSITIVE ?
YES
INDICATION OF FAILED ENABLING
BUOY MESSAGE INDICATION

Fig.5

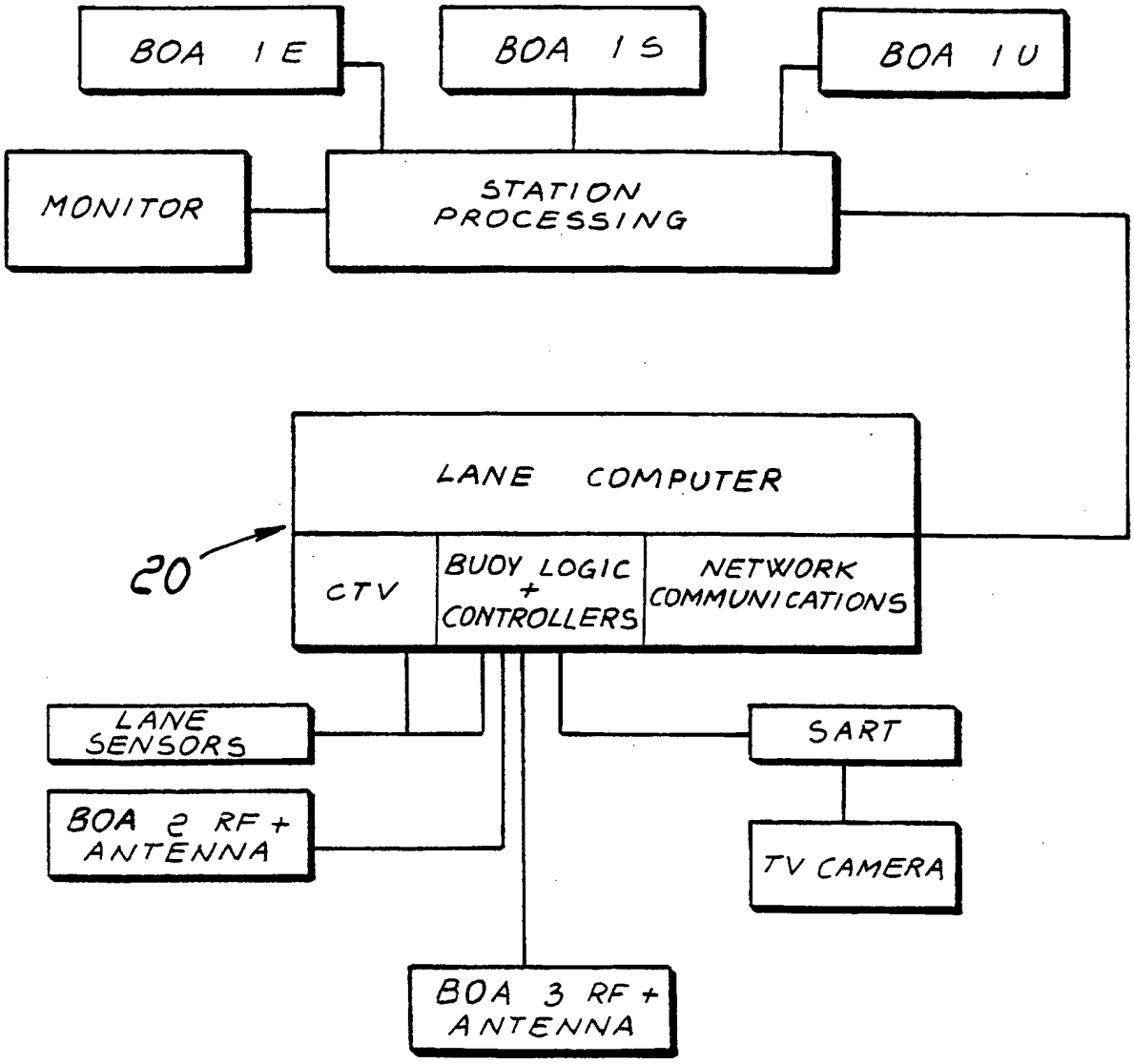
BOA 1E
BOA 1S
BOA 1U
MONITOR
STATION PROCESSING
LANE COMPUTER
20
CTV
BUOY LOGIC + CONTROLLERS
NETWORK COMMUNICATIONS
LANE SENSORS
BOA 2 RF + ANTENNA
SART
TV CAMERA
BOA 3 RF + ANTENNA

Fig. 4

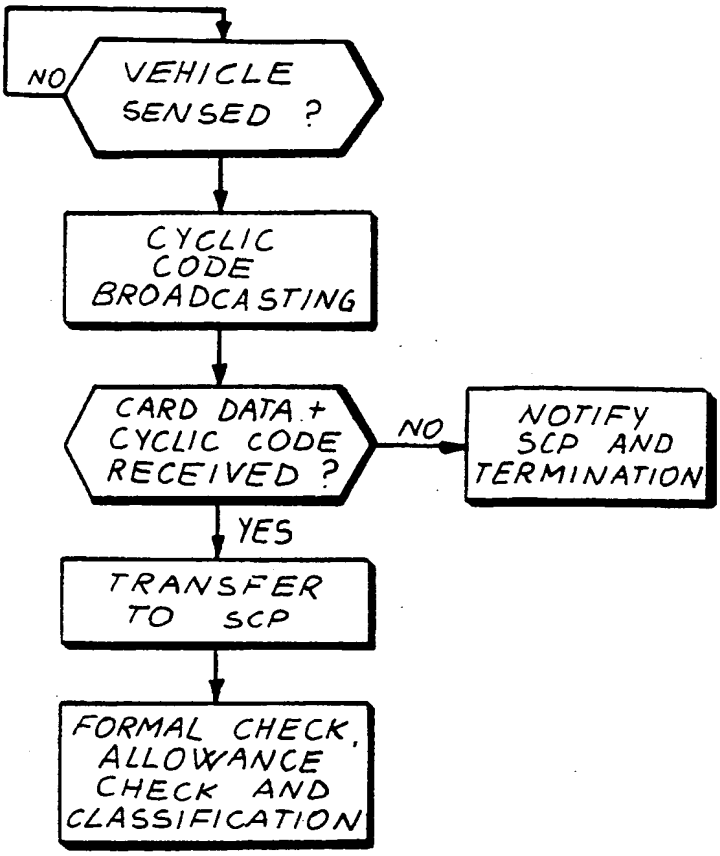
NO
VEHICLE SENSED ?
CYCLIC CODE BROADCASTING
CARD DATA + CYCLIC CODE RECEIVED ?
NO
NOTIFY SCP AND TERMINATION
YES
TRANSFER TO SCP
FORMAL CHECK, ALLOWANCE CHECK AND CLASSIFICATION

Fig. 6

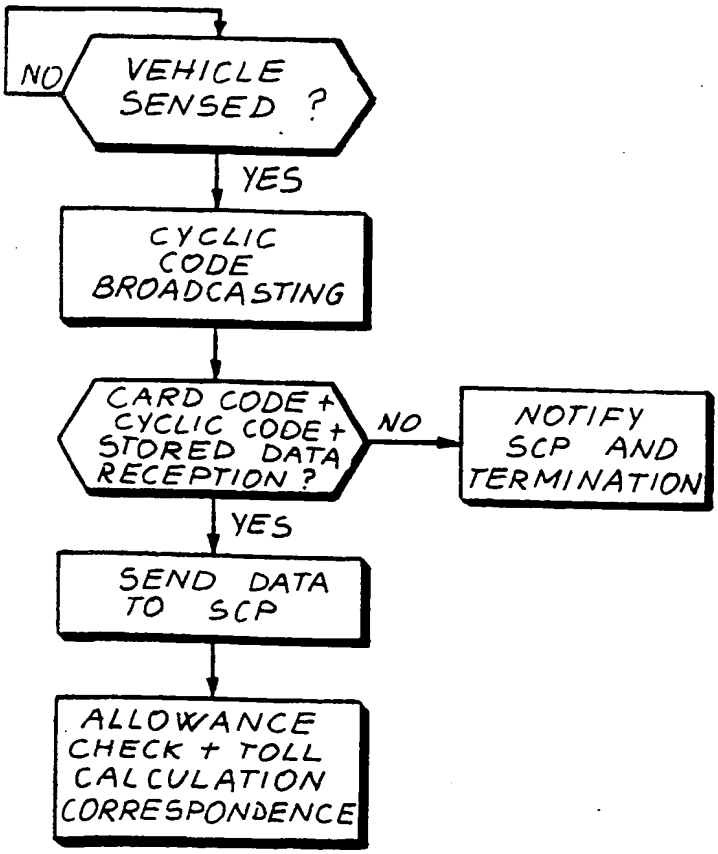
NO
VEHICLE SENSED ?
YES
CYCLIC CODE BROADCASTING
CARD CODE + CYCLIC CODE + STORED DATA RECEPTION ?
NO
NOTIFY SCP AND TERMINATION
YES
SEND DATA TO SCP
ALLOWANCE CHECK + TOLL CALCULATION CORRESPONDENCE

Fig. 8

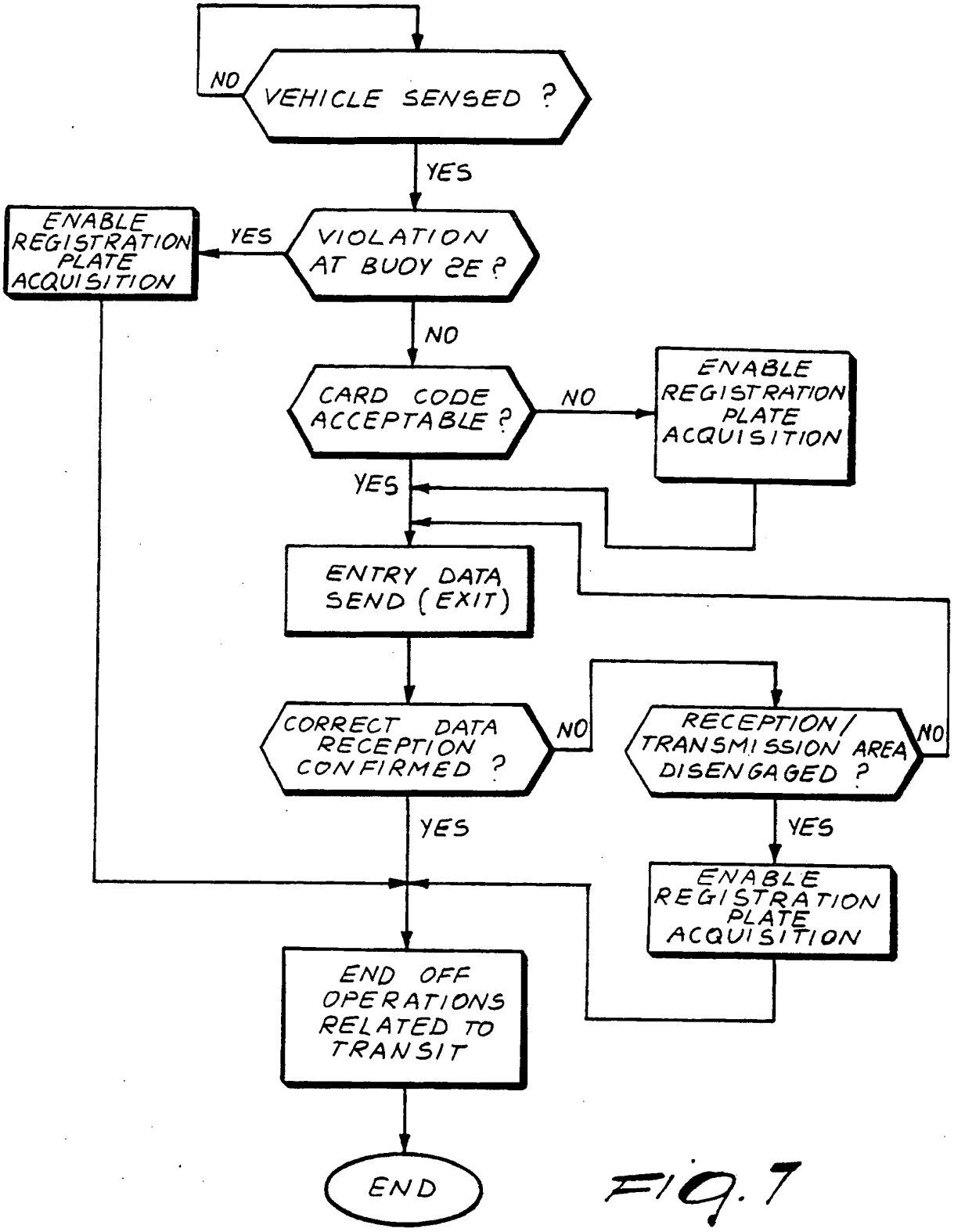
NO
VEHICLE SENSED ?
YES
ENABLE REGISTRATION PLATE ACQUISITION
YES
VIOLATION AT BUOY 2E ?
NO
CARD CODE ACCEPTABLE ?
NO
ENABLE REGISTRATION PLATE ACQUISITION
YES
ENTRY DATA SEND (EXIT)
CORRECT DATA RECEPTION CONFIRMED ?
NO
RECEPTION/ TRANSMISSION AREA DISENGAGED ?
NO
YES
YES
ENABLE REGISTRATION PLATE ACQUISITION
END OFF OPERATIONS RELATED TO TRANSIT
END

FIG. 7

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(71) Applicant: **AUTOSTRADE CONCESSIONI E COSTRUZIONI AUTOSTRADE S.P.A.**
Via A. Bergamini 50
I-00159 Roma(IT)

(72) Inventor: **Ceseri, Pierluigi**
Via Francesco da Barberino, 23
I-50100 Firenze(IT)

(74) Representative: **Modiano, Guido et al**
MODIANO, JOSIF, PISANTY & STAUB
Modiano & Associati Via Meravigli, 16
I-20123 Milano(IT)

(54) Automatic toll exaction system for urban and extraurban highways, for bridge and tunnel crossings and for accesses to urban areas and car parks.

(57) An automatic toll exaction system which comprises an onboard apparatus (5-9) which can be mounted onboard a motor vehicle (1) for the reception and transmission of messages, the handling and storage of the transactions and for interaction with the user, a personal card suitable (2) for activating the onboard apparatus, identifying the user and storing the payment transactions, and a ground-based apparatus (3,4) for ensuring the linkup with the onboard apparatus (5-9) for the exchange of data and messages, for sensing physical parameters suitable for classifying the vehicle (1) and for performing the processing of the data and parameters supplied by the onboard apparatus (5-9) and sensed by the ground-based apparatus (3,4) itself.

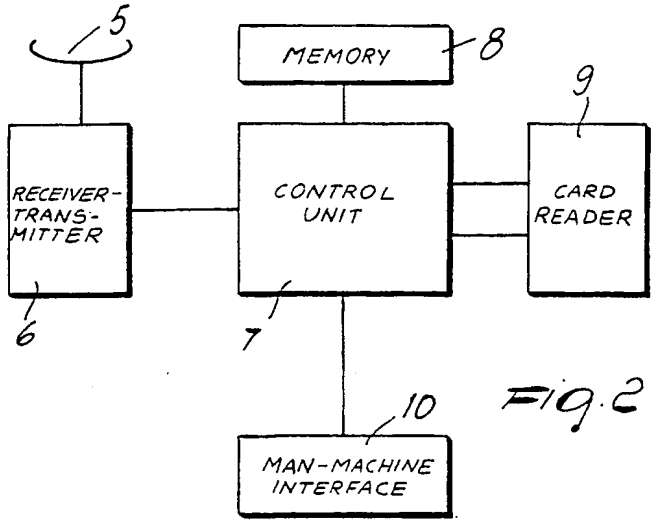

Fig. 2

EP 0 425 961 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 12 0224

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y,A	US-A-4 303 904 (CHASEK) * column 1, line 36 - column 4, line 5 * * column 5, line 19 - column 6, line 2 * * column 7, lines 21 - 33; figures *	1-4,9,12, 5-8,10, 13,14	G 07 B 15/00 G 07 C 9/00 G 08 G 1/0967
Y	EP-A-0 323 326 (SGS-THOMSON MICROELECTRONICS) * column 2, line 24 - column 4, line 17 * * column 5, line 25 - column 6, line 54; figures *	1-3,12,4, 13	
Y,A	EP-A-0 002 469 (SIEMENS) * page 2, line 11 - page 4, line 16; figures *	4,1,3,12	
Y	PATENT ABSTRACTS OF JAPAN vol. 8, no. 171 (P-293)(1608) 08 August 1984, & JP-A-59 066762 (MITSUBISHI) 16 April 1984, * the whole document *	9	
A	VEHICLE NAVIGATION & INFORMATIO SYSTEMS (VNIS'89) September 1989, TORONTO, ONTARIO, CANADA pages A31 - A35; DAVIES e.a.: "Automatic vehicle identification to support driver information systems" * page 31, column 1, lines 2 - 20 * * page 32, column 2, line 42 - page 33, column 1, line 65 EP 90120224030@ page 34, column 1, line 38 - page 35, column 1, line 40 *	1,2,5,6, 12,13	TECHNICAL FIELDS SEARCHED (Int. Cl.5) G 07 B G 07 C G 07 F G 08 G
A	FR-A-2 566 349 (ELECTRONIQUE CONTROLE MESURE) * page 1, line 3 - page 4, line 33; figures *	1,2,5-8, 12,13	
A	WO-A-8 904 093 (NYSEN) * page 8, line 2 - page 12, line 31; figures *	1-4,12	
A	FR-A-2 620 551 (RINALDI) * page 1, line 23 - page 6, line 30; figures *	1-3,12	

-/-

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	23 August 91	MEYL D.

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EUROPEAN SEARCH REPORT

Application Number

EP 90 12 0224

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	US-A-4 325 146 (LENNINGTON) * abstract; figures *	1,8,12	
X,P,A,P	FR-A-2 630 562 (NEIMAN) * page 2, line 16 - page 5, line 38; figures *	1,2,12,4, 5,8,10,13	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	23 August 91	MEYL D.

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